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Determination of standard thermodynamic properties of sulfides in the Ag-Au-S system by means of a solid-state galvanic cell

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ABSTRACT

Thermodynamic properties of the following phase reactions in the Ag-Au-S system have been investigated via electromotive force (EMF) measurements in solid-state galvanic cells with Ag_4RbI_5 as a solid electrolyte:

$Ag(cr) + Ag_3AuS_2(cr) = 2Ag_2S(cr) + Au(cr)$
$Ag(cr) + 2AgAuS(cr) = Ag_3AuS_2(cr) + Au(cr)$
$Ag(cr) + Au_2S(cr) = AgAuS(cr) + Au(cr)$
$AgAuS(cr) + Ag_2S(cr) = Ag_3AuS_2(cr)$

The EMF temperature dependences observed for these reactions, together with auxiliary thermodynamic properties for Ag_2S, acanthite, from Robie and Hemingway (1995), result in the following standard thermodynamic properties at 298.15 K and 1 bar (10^5 Pa): $\Delta_f G^o(Ag_3AuS_2, cr) = -69478(200)$ J/mol and $S^o(Ag_3AuS_2, cr) = 273.37(56)$ J/(mol·K) (uytenbogaardtite), $\Delta_f G^o(AgAuS, cr) = -27621(210)$ J/mol and $S^o(AgAuS, cr) = 128.11(60)$ J/(mol·K) (petrovskaite), and $\Delta_f G^o(Au_2S, cr) = 1077(650)$ J/mol and $S^o(Au_2S, cr) = 128.1(2.0)$ J/(mol·K). $Au_2S(cr)$ is a thermodynamically metastable phase, but the values of its thermodynamic functions are open to discussion.